INVESTIGATION AND REPORT

ON THE

MANUFACTURE OF DESSICATED MILK

BY THE

ANDREWS PATENT PROCESS

AS COVERED BY

UNITED STATES PATENT NUMBER 1,012,578

AND BY MANY FOREIGN PATENTS

FREDERIC BUCH

ENGINEER

43 EXCHANGE PLACE, NEW YORK CITY

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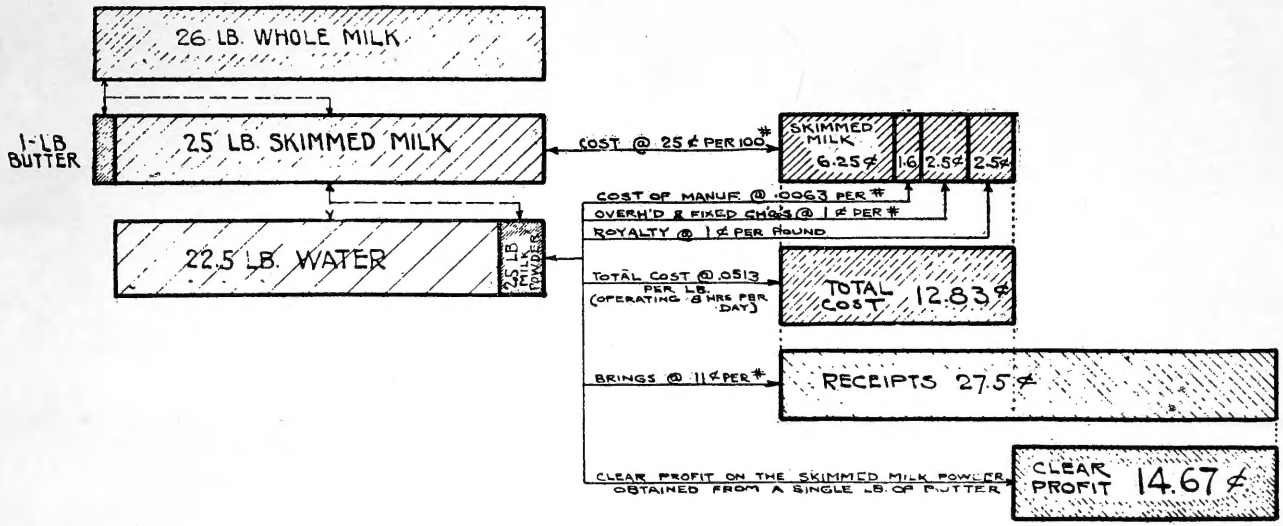
INDEX

DIAGRAM SHOWING WHOLE MILK REQUIRED FOR ONE POUND OF BUTTER AND SKIMMED MILK REMAINING, TOGETHER WITH VARIOUS COSTS, AND THE PROFITS FROM THE MILK POWDER.



The figures in this diagram are based on an 8-hour day of operation. It will be seen that with

Skimmed milk at 2.5 c per 10 lbs.(=1 lb. powder.)
Cost of man'f't'e .63c per lb. of powder.
Overhead and fixed charges.. 1.00c per lb. of powder.
And royalty..... 1.00c per lb. of powder.

5.13c cost per lb. of powder.

For 2.5 lbs. we have 5.13×2.5=12.83c total cost.
Selling the powder at 11c per lb.=2.5×11=27.5c.
Profit on 2.5 lbs. of milk powder made from 25 lbs. of skimmed milk is 27.5−12.83=14.67c.

HOW MILK POWDER IS MADE

TYPICAL MILK POWDER PLANT

By referring to the accompanying diagram a comprehensive working knowledge of a milk drying plant will be had, the diagram showing a layout of the machinery, apparatus, vats, tanks, etc., through which the milk must pass from the time it first enters the plant until it is packed in barrels, boxes, or cartons; the finished product, ready for shipment.

PROCESS OF MANUFACTURE

Milk enters the plant immediately after being weighed on the wagon scales and is dumped from the milk wagons so that it will flow by gravity into cold storage vats, where it is accumulated until the quantity becomes sufficient to start the plant. The milk is then caused to flow into a regulating tank, located just above the cream separators, as shown. By means of this tank the flow of the milk into the separators is adjusted and controlled as desired.

Milk and cream are now separated, and, if butter is to be made, the cream led to a cream storage tank and thence to the butter-making machinery, while the skimmed milk passes through a degermer where bacteria is destroyed and the milk purified by a patent process.

The skimmed milk now passes into the main evaporator, where evaporation is affected until it becomes about the same consistency as the pure cream in the cream tank, or ordinary condensed milk.

This condensed milk now flows into the mixing or revitalizing tank, where it is revitalized by the introduction of pure filtered air, and, if no butter is to be made, the cream and condensed milk are here united.

The two, now being of the same consistency, may be forced together into the secondary evaporator or drum, where the remaining moisture is quickly evaporated and carried off, the milk and cream, or milk only, now forming chips or strips of a yellowish appearance.

These milk strips and chips, being very damp, are next passed into a tumbler directly under the drum, where they are broken into particles and brought into contact with hot dry air, to be dried out as completely as possible before being allowed to enter the pulverizer or grinder, for the final grinding into milk flour or powder of a suitable fineness desired by the trade.

That nothing may be lost or wasted, the grinder is enclosed in an air-tight casing and connected by a powerful suction fan to a dust collector, where every particle of the powdered milk is collected and then allowed to flow into barrels or boxes to be removed to the store room or shipping platform.

For this purpose a mechanical conveyor may be brought into use if desired, as indicated in the diagram, but as the average grinder or pulverizer now on the market could hardly produce more than one barrel (360 pounds) of powder per hour under the most favorable conditions, it will be seen that a conveyor is hardly a necessity.

From the foregoing it will be seen that, if based on the right principles, the process is simple indeed, and that if the machinery is properly designed and proportioned no skilled labor will be required, as everything is arranged to work automatically and with a mechanical precision that smirks of the best efforts of the trained or skilled hand.

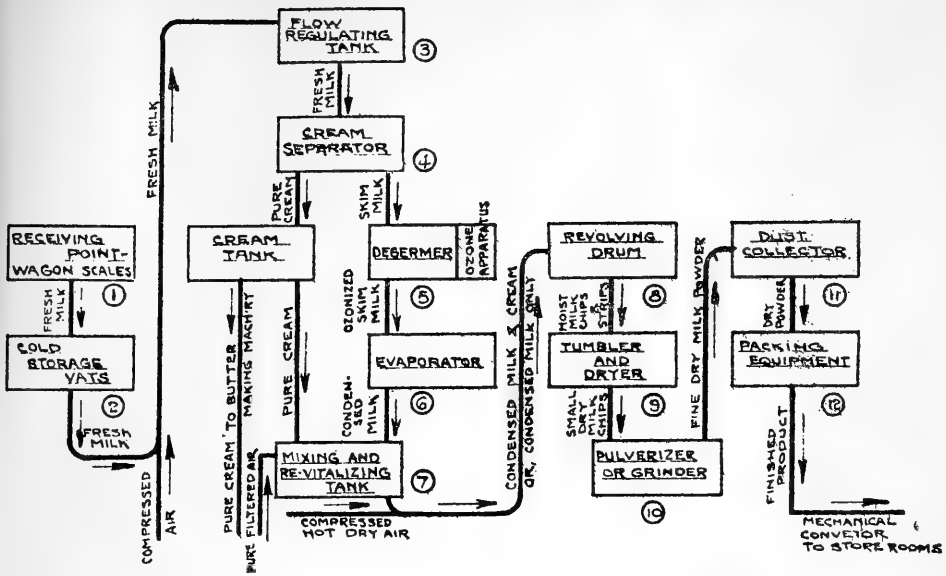
THE ACCOMPANYING TABLE

To give a still clearer outline and better understanding of the process just described, the table under the diagram has been added. The consecutive numbers in the first column give exactly, in running order, the routing of the milk through the plant, while the second and third columns give the names of the various apparatus or parts, and their respective functions.

OTHER MECHANICAL EQUIPMENT

Engine and boiler, air heater and dryer, air compressor, the various piping systems and other minutae have been purposely omitted from the diagram as the interest here is centered on the process of manufacture rather than on mechanical details, which in some instances need but slight consideration, as they already form part of a plant to which the milk powder machinery may be added.

NOTE.—If this process was not based on the right principles, the German patent would not have been allowed —and the German Government *protects* its basic patent grants.—*Inventor.*



DIAGRAMATIC LAYOUT OF APPARATUS AND PIPING
FOR COMPLETE MILK POWDER PLANT
SHOWING EXACT TRAVEL OF MILK IN BEING TREATED
NOTE - ARROWS INDICATE DIRECTION OF FLOW.

Table 1.—Routing of Milk

NUMBER	MACHINERY OR APPARATUS	FUNCTION
1	Wagon Scales.	Weigh milk as received.
2	Cold Storage Vats.	Store and preserve milk until needed, or until quantity becomes sufficient to start plant.
3	Flow Regulating Tank.	Regulate and adjust flow of milk into the cream separators so the latter cannot choke or become overloaded.
4	Milk and Cream Separators.	Separate cream from milk so that the former may be used for butter and the latter for milk powder products, or the two brought to the same consistency to be reduced to powder together.
5	Degermer.	Purify milk and kill bacteria without causing coagulation or destroying life and protein as is the case with pasteurizing.
6	Evaporator.	Evaporate principal moisture from the skim milk and reduce it to the same consistency as pure cream without causing boiling or burning of the milk.
7	Mixing and Re-vitalizing Tank.	Re-unite and re-vitalize cream from separators and condensed milk from evaporators by the introduction of pure filtered air.
8	Revolving Drum or Secondary Evaporator.	Complete evaporation of moisture from re-vitalized condensed milk, or from combined milk and pure cream.
9	Tumbler and Dryer.	Break up into small particles, and dry out evaporated product, and prepare same for pulverizer or grinder.
10	Pulverizer or Grinder.	Grind dried product to desired fineness.
11	Dust Collector.	Forcibly collect from pulverizer, by powerful air suction, every particle of milk powder or flour and chute it into barrels, boxes, cartons, etc.
12	Packing Equipment.	Suitable arrangement for sealing barrels or boxes and transferring them to store-rooms or shipping platform by means of mechanical conveyors.

Table of Operating Costs and Clear Profits Per Day

OPERATING EXPENSES and CLEAR PROFIT FOR ONE PLANT WITH VARIOUS QUANTITIES OF MILK.

NUMBER OF 4 HR. RUNS	MILK SUPPLY POUNDS	MILK SUPPLY QUARTS (APPROX.)	FINISHED POWDER IN POUNDS	MACHINE HOURS PLANT-EXCEPT PULVER	MACHINE HOURS PULVERIZER	HORSE POWER CONSUMED PLANT-EXCEPT PULVER	HORSE POWER CONSUMED PULVERIZER	TOTAL ACTUAL H.P. CONSUMED	COST OF H.P. (COAL ONLY)	COST OF SKIM. MILK	COST OF BARRELS	COST OF LABOR	OVERHD & FIXED CHG'S	ROYALTY	TOTAL COST PER DAY	TOTAL COST PER LB.	GROSS RECEIPTS PER DAY @ 11¢ PER LB.	CLEAR PROFIT PER DAY OVER ALL EXPENSES
	10 000	5 000	1000	2.0	6.6	30	100	150	3.00	25.00	.45	11.50	40.00	10.00	89.95	.089	110.00	20.05
	12 000	6 000	1200	2.4	8.0	60	120	180	3.60	30.	.54	"	"	12.	97.64	.081	132.00	34.36
	14 000	7 000	1400	2.8	9.3	70	140	210	4.20	35	.63	"	"	14.	105.33	.075	154.00	48.67
	16 000	8 000	1600	3.2	10.6	80	160	240	4.80	40.	.72	"	"	16	113.02	.071	176.00	62.98
	18 000	9 000	1800	3.6	12.0	90	180	270	5.40	45	.81	"	"	18	120.71	.067	198.00	77.21
1	20 000	10 000	2000	4.0	13.3	100	200	300	6.00	50.	.90	"	"	20	128.40	.064	220.00	91.60
	22 000	11 000	2200	4.4	14.6	110	220	330	6.60	55.00	.99	11.50	40.00	22.00	136.09	.062	242.00	105.91
	24 000	12 000	2400	4.8	16.0	120	240	360	7.20	60.	1.08	"	"	24.	143.78	.061	264.00	120.22
	26 000	13 000	2600	5.2	17.3	130	260	390	7.80	65.	1.17	"	"	26.	151.47	.059	286.00	134.53
	28 000	14 000	2800	5.6	18.6	140	280	420	8.40	70.	1.26	"	"	28.	159.16	.057	308.00	148.84
	30 000	15 000	3000	6.0	20.0	150	300	450	9.00	75	1.35	"	"	30.	166.85	.055	330.00	163.15
	32 000	16 000	3200	6.4	21.3	160	320	480	9.60	80.00	1.44	11.50	40.00	32.00	174.54	.054	352.00	177.46
	34 000	17 000	3400	6.8	22.6	170	340	510	10.20	85.	1.53	"	"	34.	182.23	.053	374.00	191.67
	36 000	18 000	3600	7.2	24.0	180	360	540	10.80	90.	1.62	"	"	36.	189.92	.053	396.00	206.08
	38 000	19 000	3800	7.6	25.3	190	380	570	11.40	95.	1.71	"	"	38.	197.61	.052	418.00	220.39
2	40 000	20 000	4000	8.0	26.6	200	400	600	12.00	100.	1.80	"	"	40.	205.30	.051	440.00	234.50
	42 000	21 000	4200	8.4	28.0	210	420	630	12.60	105.00	1.89	11.50	40.00	42.00	212.99	.051	462.00	249.01
	44 000	22 000	4400	8.8	29.3	220	440	660	13.20	110.	1.98	"	"	44.	220.68	.050	484.00	263.32
	46 000	23 000	4600	9.2	30.6	230	460	690	13.80	115.	2.07	"	"	46.	228.37	.049	506.00	277.63
	48 000	24 000	4800	9.6	32.0	240	480	720	14.40	120.	2.16	"	"	48.	236.06	.049	528.00	291.94
	50 000	25 000	5000	10.0	33.3	250	500	750	15.00	125.	2.25	"	"	50.	243.75	.049	550.00	306.25
	52 000	26 000	5200	10.4	34.6	260	520	780	15.60	130.00	2.34	11.80	40.00	52.00	251.74	.048	572.00	320.26
	54 000	27 000	5400	10.8	36.0	270	540	810	16.20	135.	2.43	12.10	"	54.	259.73	.048	594.00	334.27
	56 000	28 000	5600	11.2	37.3	280	560	840	16.80	140.	2.52	12.40	"	56.	267.72	.048	616.00	348.28
	58 000	29 000	5800	11.6	38.6	290	580	870	17.40	145.	2.61	12.70	"	58.	275.71	.048	638.00	362.29
3	60 000	30 000	6000	12.0	40.0	300	600	900	18.00	150.	2.70	13.00	"	60.	283.70	.048	660.00	376.30

NOTE.—To find number of cows required to produce a given quantity of milk powder, divide quarts in quart column by 12. Example: 5,000 divided by 12 (the average per day, per cow) and we find 417 cows will produce 1,000 lbs of powder; 30,000 divided by 12, or 2,500 cows, making 6,000 lbs.

Table for Estimating Clear Earnings for One Plant Per Year

Milk Supply in Pounds	Running Hours of Plant	Months											
		1	2	3	4	5	6	7	8	9	10	11	12
10 000	2.0	615.	1230	1845	2460	3075	3690	4305	4920	5535	6150	6765	7380
12	2.4	1030.	2060	3090	4120	5150	6180	7210	8240	9270	10308	11330	12360
14	2.8	1462.	2924	4386	5848	7310	8772	10234	11696	13158	14628	16082	17544
16	3.2	1889.	3778	5667	75556	9445	11334	13223	15112	17001	18894	20799	22668
18	3.6	2316.	4632	6948	9264	11580	13896	16212	18528	20844	23163	25476	26792
20	4.0	2743.	5496	8244	10992	13740	16488	19236	21984	24732	27480	30288	32976
22 000	4.4	3177.	6354	9531	12 708	15885	19062	22239	25416	28593	31773	34947	38 124
24	4.8	3606.	7212	10818	14424	18030	21636	25242	28848	32454	36066	39666	43272
26	5.2	4035.	8070	12105	16140	20175	24210	28245	32280	36315	40359	44385	48420
28	5.6	4465.	8930	13335	17860	22325	26790	31255	35720	40185	44652	49115	53580
30	6.0	4894.	9788	14592	19576	24470	29364	34258	39152	44046	48945	53834	58728
32 000	6.4	5323.	10646	15969	21292	26615	31938	37261	42584				
34	6.8	5750.	11500	17250	23000	28750	34500	40250	46000				
36	7.2	6182.	12364	18546	24728	30900	37092	43274					
38	7.6	6611.	13222	19833	26444	33055	39666						
40	8.0	7065.	14130	21195	28260	35325	42390						
42 000	8.4	7470.	14940	22410	29880	37350							
44	8.8	7899.	15798	23697	31596	39495							
46	9.2	8328.	16656	24984	33312								
48	9.6	8758.	17516	26274	35032								
50 000	10.0	9187.	18374	27561	36748								
52 000	10.4	9607.	19214										
54	10.8	10028.	20056										
56	11.2	10448.	20896										
58	11.6	10868.	21736										
60 000	12.0	11289.	22578										

EXAMPLE—

If the milk supply is 40,000 lbs. for 3 months, 38,000 lbs. for 2 months, 36,000 lbs. for 1 month, 30,000 lbs. for 1 month, 20,000 lbs. for 3 months, with the plant lying idle the other 2 months, what should be the clear profits for the year?

ANSWER—

Opposite	40,000	lbs. under	3	months we find	$21,195
"	38,000	"	2	" "	13,222
"	36,000	"	1	" "	6,182
"	30,000	"	1	" "	4,894
"	20,000	"	3	" "	8,244
Total, clear profits					$53,737

GENERAL EXPENSES

Overhead and Fixed Charges

Salary of principal	$6.00
Traveling expenses of principal	4.00
Advertising	
Gifts to customers	.50
Interest on capital (5% on $7,000)	1.00
Interest on borrowed money	
Rent (assumed at 8% on value of property)	2.63
Stationery, postage, telephone, telegraph	.50
Insurance:	
Fire—$30 per 1,000 on $12,000 property	1.98
Credit	2.00
Partnership	
Casualty	
Bonds	
Liability	
Depreciation of plant	1.00
Repairs	1.00
Unjust claims of customers (1% on $100,000)	2.73
Damage, loss, freight and express charges on returned goods	
Collections	2.73
Bad debts	2.73
Factory supplies and equipment	2.00
Office supplies and equipment	.50
Lighting	.50
Taxes (assumed at $18 per M)	.35
Legal expenses	.50
Maintaining three horses	1.50
Refrigeration	5.00
Charity	.50
Miscellaneous expenses	.35
Total	$40.00 per day.

NOTE.—The above is a fair estimate for average conditions. Close inspection may show, however, that not all the items taxed above will enter in every condition, and the overhead and fixed charges may therefore be even less than the quoted $40.00 per day.

Various Operating Charges

LABOR—

Machinist in charge $4.00 salary.
Night watchman...
Fireman ..... 2.50 per day.
Driver .....
Men at grinders—2
at $2.50..... 5.00 per 10-hour day or less.

Total $11.50

ESTIMATED HORSEPOWER—

Evaporator	2 h. p.
Drum and Tumbler	1 "
Air Compressor	10 "
Hot air exhauster	10 "
Air dryer and heater	2 "
Pulverizer or grinder	15 "
Total, with 1 grinder	40 h. p.
with 2 grinders	55 h. p.

COST OF FUEL—

Coal assumed at $5.00 per ton of 2,000 lbs.
Eight (8) lbs. of coal per h. p. per hour.
This gives cost of coal at 2 cents per h. p. per hour.

MILK SUPPLY—

Price of skimmed milk assumed at 25 cents per 100 lbs.

BARRELS FOR PACKING FINISHED POWDER—

Barrels assumed at 15 cents each when bought in lots.
360 lbs. of powder per barrel, 2.77 barrels per 1,000 lbs.
This gives 41½ cents, say 45 cents, per 1.000 lbs.

ROYALTY—

In order to obtain the exact clear profit, over and above all ordinary possible expenses, the royalty is here included with the operating expenses.
The royalty amounts to one (1) cent per pound of milk powder.

EVAPORATOR

The evaporator shown in the accompanying illustration serves to reduce skimmed milk to the consistency of condensed milk, by evaporating about 75% of the moisture. This should be accomplished without the milk reaching 156 degrees F, as at that temperature the albumen is coagulated and a cooked taste acquired.

In the Andrews System this difficulty is overcome by rapid alternating heating and chilling of the milk, instead of a heating process alone (as is the case in all other methods, none of which are a complete success), the slight chilling always occurring just as the milk reaches the maximum allowable temperature before boiling or burning, thus automatically preventing overheating of the same.

The illustration shows the evaporator in section, both from the front and side. It consists mainly of a sheet metal casing carried by an angle iron frame made up practically air-tight, with inlet pipes at the top for the skimmed milk to be treated, and outlets at the bottom through which the condensed milk passes to the re-vitalizing tank. There are also large inlet and outlet connections for the hot dry air used to absorb and carry off the moisture evaporated from the milk.

Access doors are provided on three sides for cleaning and inspection purposes. These are closed air-tight when the evaporator is in operation.

The perforated spread pipes at the top serve to evenly distribute the incoming milk. The slightly inclined corrugated plates directly under the spread pipes are of wired glass for sanitary reasons. Their purpose is to heat the milk to a certain desired temperature so that evaporation may immediately commence when the liquid strikes the upper hot rollers. The plates are heated from the iron pipe coils shown directly underneath.

The rollers, over which the milk must pass, are also of wired glass, or, they may be made of cast iron with a heavily nickeled surface to resist the corrosive action of the heated milk. They are hollow so that steam or electric heat and ammonia gases may be passed through alternate rollers, thus causing a perfect hot and cold process for treating the milk.

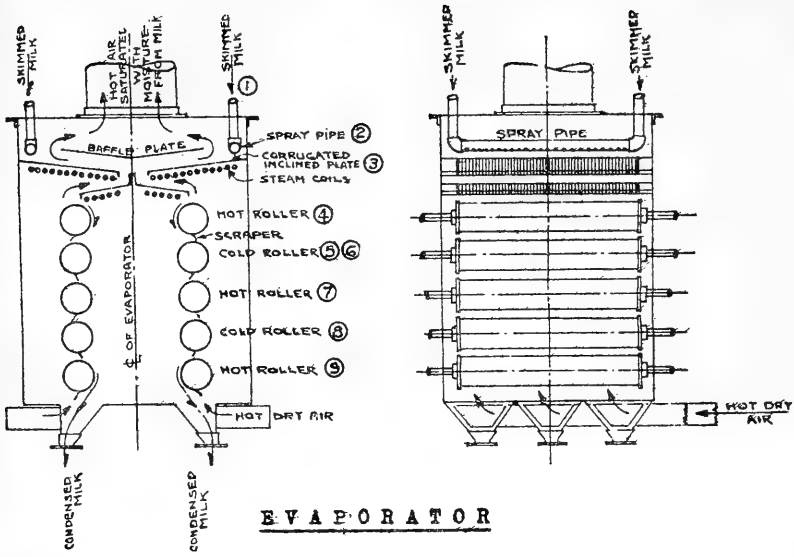
The inlet pipes to these rollers are fitted with thermometers, pressure gauges, and instantly adjustable pressure regulating valves, thus allowing the minutest adjustment of temperatures. The rollers rotate with the inlet and outlet pipes acting as the shafts—they are driven by a sprocket chain on the outside of the casing.

Each roller is fitted on the under side with an automatic scraper, held tight against the same by adjustable springs. These springs prevent the milk from clinging to the surface of a roller beyond the specified time.

The machine is so proportioned that the layer of milk on the surface of the upper rollers will be approximately 1/32" in thickness, while on the successive rollers it will necessarily be proportionately less. The temperatures and speed are carefully adjusted at the first operation and are thereafter constant, making the entire process of evaporation a mechanical one with no need for skilled or specially trained help.

The rotating pipe ends of the rollers are connected to the inlet and outlet pipes with special stuffing boxes and extra long glands, so there can be no escaping of steam or gases and all oil bearings are located on the outside of the casing of the machine.

The outlets at the bottom, through which the condensed milk must pass, are fitted with test cocks so that samples of every run of milk may be taken, if desired, and thus an absolute check kept on the high quality of the product.



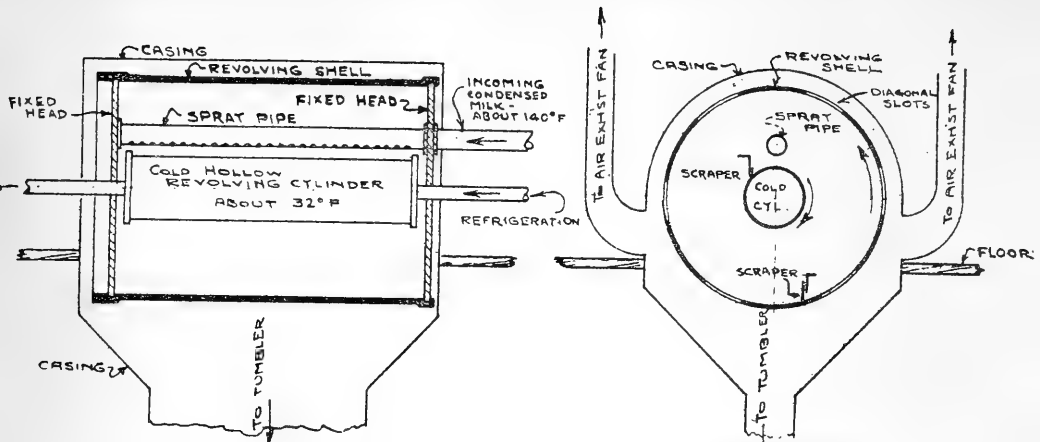
EVAPORATOR

1. Milk enters from the degermer through the pipes shown at the top.
2. It is spread and evenly distributed by passing through the small holes in the spread pipes.
3. The milk now flows slowly in a very thin sheet, over the heated and slightly inclined corrugated plates, the temperature rising to approximately 90 degrees F.
4. It now falls from the plates to the upper or first hot rollers (one on each side), and passes half way round the same in an even layer about 1/32" thick, at the same time rising to about 140 degrees and giving off part of its moisture which is immediately absorbed by the hot dry air passing through the apparatus at a high speed.
5. The milk is next forced from the under side of the hot rollers to the cold rollers. This is accomplished by the knife-edge scrapers.
6. It passes half way around the cold rollers and is thus slightly cooled.
7. It is again scraped off and passes to the next hot rollers, where evaporation is again caused with the temperature reaching 140 F.
8. The milk is again cooled on the cold roller.
9. It now passes over the final (bottom) hot rollers where more moisture is evaporated at the temperature stated above. Scraper blades force it from these rollers as from the preceding ones to prevent boiling, burning or overheating.

About 75% of the moisture in the milk has now been evaporated without the milk at any time being overheated, the immense volumes of hot dry air passing over the rollers greatly assisting in the process of evaporation. The milk is now the consistency of condensed milk, and may, if desired, be sold as such, after passing through a re-vitalizing process with pure filtered air.

If milk powder is to be made, the re-vitalized condensed milk passes to the drum, described on the following sheet.

No milk is allowed to accumulate in the bottom of the evaporator, the product being forced, by air blast, into the re-vitalizing tank as fast as it falls from the bottom rollers.



D R U M

The drum shown herewith consists of a revolving shell running on the two fixed heads, with a light metal casing enclosing the entire apparatus. This shell is driven by gear wheels, not shown.

The condensed milk from the re-vitalizing tank is forced into the spread pipe by compressed air heated to a high temperature, and is spread in fine streams, at a temperature of approximately 140 F, on to the hollow revolving cylinder, which is kept to about 32 degrees F by refrigeration. The heat contact is very limited.

The heated milk, coming in sudden contact with the very cold surface of the roller, instantly congeals the milk into ribbons and strips.

These ribbons and strips are continually scraped from the cold roller and the inner surface of the revolving shell (upon which they subsequently fall) and carried through slots in the revolving shell to be passed into the tumbler.

The latter, which is a very simple apparatus for breaking up the ribbons and strips, is located immediately under the drum. Hot dry air is forced through this tumbler in great quantities to further dry out the milk. It is drawn off by the air exhaust fan through the two pipes shown in the cross section.

Tumbler and drum have the same capacity as the evaporator, so that no storing of the condensed milk will be required.

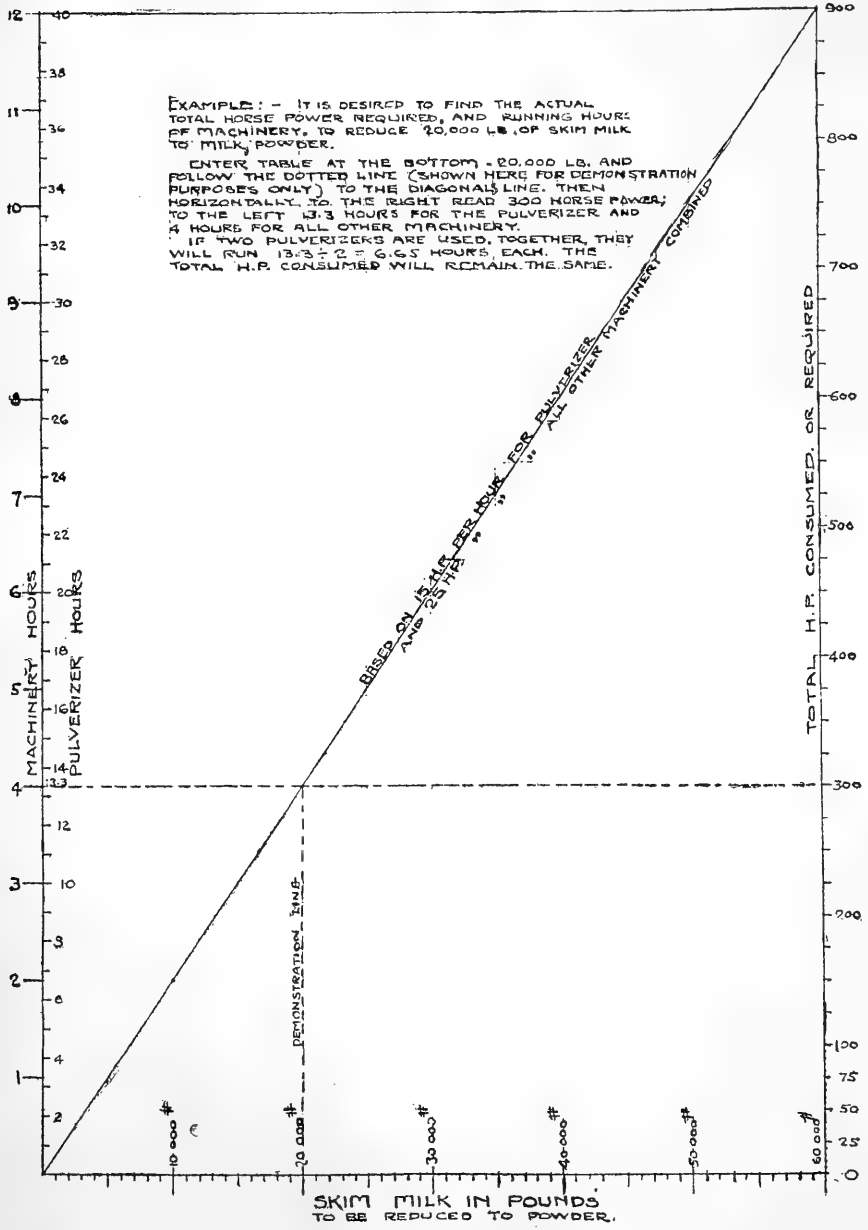
COST OF MACHINERY

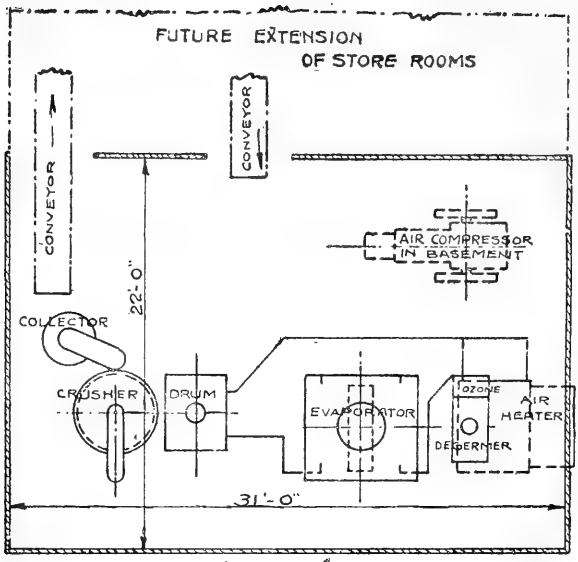
Evaporator	$ 750.00	
Drum	250.00	
Tumbler	50.00	
Degermer	150.00	
2 Pulverizers at $1,140.00	2,280.00	
Air heater box and pipe coils	50.00	
Air exhaust fan	320.00	
Air compressor	350.00	(Estimated costs being given as maximum, the actual cost will be less than total of $5,375.)
Air receiver tank	25.00	
Revitalizing tank	25.00	
Flow regulating tank	25.00	
Steam and water piping	50.00	
Hot dry air piping	100.00	
Millwrighting (shafting, pulleys, etc.)	150.00	
Machinery foundations	300.00	
Erection of machinery	500.00	
Total	$5.375.00	
Additional working capital	1,625.00	
Grand Total	$7,000.00	

NOTE.—It is assumed that the plant is annexed to a creamery which will furnish the power required, steam heat, refrigeration, pure fresh water, etc.

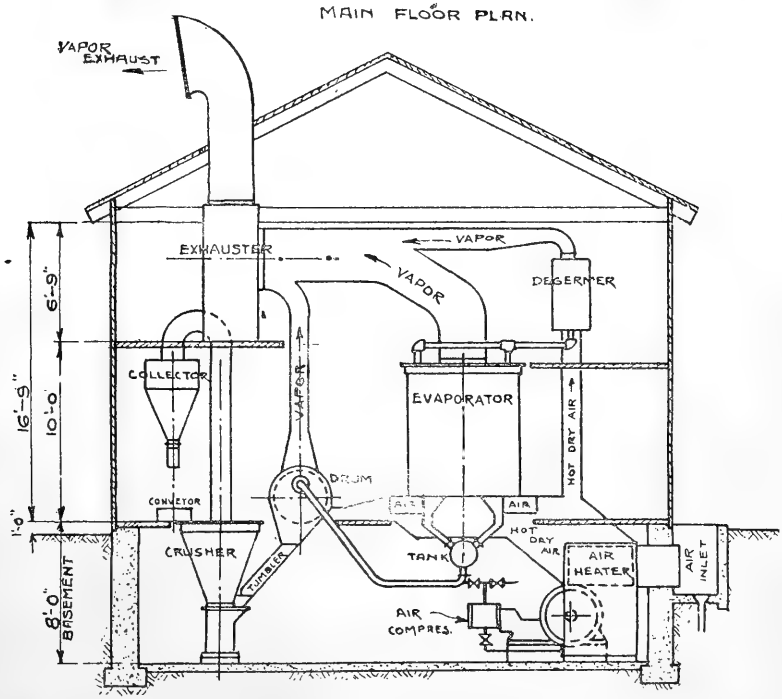
DIAGRAM FOR CALCULATING RUNNING TIME OF MACHINERY AND TOTAL H. P. CONSUMED FOR ANY QUANTITY OF MILK FROM 1 TO 60,000 LBS. INCLUSIVE.

NOTE:—ONE QUART OF MILK EQUALS TWO POUNDS.





MAIN FLOOR PLAN.



CROSS - SECTION

SOME MILK POWDER PRODUCTS

	PRODUCT	USE	PACKED IN	SOLD TO	METHOD
1	MILK POWDER	General	Barrels	Bakers Confectioners	Direct
2	MILK FLOUR	Home Use	Cartons	Grocery Trade	Jobbers
3	MILK FLAKES	"	"	"	"
4	MILK DOMINO CRYSTALS	"	"	"	"
5	MILK JELLY	"	Glass Jars	"	"
6	MILK CUBES	Tourists Soldiers	Tins	Grocers Confectioners	"
7	MILK GRANULES	Infants Invalids	Bottles	Drug Trade	"
8	MILK POWDER CAPSULES	Invalids	Glass Jars	"	"
9	MILK WAFERS	Confectioners	Wax Paper	Druggists Confectioners	"
10	MILK STICKS	"	"	"	"
11	MILK FLESH FOOD	General	Boxes	Drug Trade	"
12	TOILET MILK PREPARATIONS	"	"	"	"